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AUTHOR Buckley, Patricia A.; Ribordy, Sheila C.
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ABSTRACT

This study was designed to investigate mathematics performance as a function of anxiety, with examination for a relationship between mathematics and test anxiety and any sex differences on mathematics anxiety. The effects of evaluative stress on high and low mathematically anxious subjects was examined, and preliminary effort was made to investigate possible relationships between anxiety and sex-typed versus androgynous sex-role identification. A total of 20 male and 20 female subjects were selected from a pool of 101 undergraduates pretested on the Mathematics Anxiety Rating Scale (MARS) and the Bem Sex-Role Inventory (BEM). The data generated seemed to corroborate many previous research findings regarding mathematics anxiety and offer new implications with respect to its distinctiveness. Among the results, it is noted that sex-role typing did not emerge as a significant contributing variable to the prevalence or distribution of anxiety. Results also suggested that mathematics anxiety differs from test anxiety in its being less affected by evaluative and/or reassuring instructions. Implications for treatment suggested by the analysis are presented. (MP)

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Mathematics Anxiety and the Effect of Evaluative Instructions on Math Performance

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Patricia A. Buckley Sheila C. Ribordy

DePaul University

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INTRODUCTION

The concept of mathematics anxiety has received increasing attention over the past number of years by numerous researchers. It is a timely concern, what with the advent of our computer age as well as the widening array of vocations, particularly for women, that require a theoretical and practical knowledge of mathematics.

Math anxiety has been described as an irrational dread of mathematics that interferes with manipulating numbers and solving mathematical problems within a variety of every day life and academic situations (Lazarus, 1974; Richardson & Suinn, 1972). The behavioral manifestations of math anxiety have been postulated to range from anxiety over balancing a checkbook to an active avoidance of math and math-related areas (Donady & Tobias, 1977; Richardson & Suinn, 1972).

Research has demonstrated that mathematics test performance correlates negatively with measures of math anxiety across a variety of subject populations including college students (Betz, 1978; Richardson & Suinn, 1972; Suinn, et al., 1972), grade school children (Sepie & Keeling, 1978), and adult women returning to college (Hendel, 1980). Levels of math anxiety have also been found to vary inversely with previous math preparation, as in number of semesters or years of high school math (Betz, 1978; Hendel, 1980).

Although math anxiety has been postulated to represent a factor distinct from either general or test anxiety, there is a high positive correlation between measures of math and test anxiety. Richardson and Woolfolk (1980) suggest that the cognitive and emotional components of math anxiety are quite similar to those of test anxiety.

One of the purposes of the present study was to investigate the extent of this similarity between math and test anxiety.

The test anxiety literature is replete with studies demonstrating the interaction effects of evaluative stress instructions on high and low test anxious subjects. It is well documented that high test anxious individuals are more likely to be detrimentally affected by evaluative testing instructions whereas low test anxious subjects are more likely to be beneficially affected by evaluative instructions. Conversely, reassuring instructions typically have more of a beneficial effect on the test performance of high test anxious subjects as compared to the performance of low test anxious subjects under similar reassuring conditions (Sarason, 1980; Wine, 1971).

It was thus hypothesized in the present study that high math anxious subjects would perform poorer under evaluative stress instruction conditions than either high math anxious subjects under reassuring conditions and low math anxious subjects in either instruction condition.

Furthermore, the concept of math anxiety has been widely used an an explanatory variable for sex-related differences in mathematics performance and enrollment in mathematics curricula (Rounds & Hendel, 1980). However, sex differences in math performance, with women reported to perform poorer than men, is a controversial topic with the research providing inconsistent results to substantiate this generally widely accepted belief (Fennema, 1977). The available research investigating sex differences in math anxiety is equally inconsistent. When a sex difference is found, women typically report significantly higher levels of math anxiety than men. This sex difference, however,

is reduced to chance levels when other relevant variables are controlled and held constant (i.e. previous mathematics preparation) (Betz, 1978; Brush, 1978).

Thus, the purpose of the present study was threefold:

The first purpose was to investigate mathematics performance as a function of math anxiety. Additionally, the relationship between math and test anxiety was investigated. The math anxiety sex difference hypothesis was tested with and without control for previous mathematics experience.

Secondly, the effects of evaluative stress on high and low math anxious subjects' test performance was examined. Finally, a preliminary effort was made to investigate the possible relationship between math anxiety and sex-typed versus adrogynous sex-role identification.

METHOD

Subjects for the pretesting session were 49 male and 52 female undergraduate students. Subjects were pretested on the Mathematics Anxiety Rating Scale (MARS; Richardson & Suinn, 1972) and the Bem Sex-Role Inventory (BSRI; Bem, 1974).

Subjects for the experimental session were 20 males and 20 females selected from the 101 pretested subjects on the basis of their MARS scores. Twenty subjects scoring high in math anxiety and 20 subjects scoring low in math anxiety were chosen. These subjects were randomly assigned to either the high evaluative stress instruction condition or the low evaluative stress instruction condition. The proportion of males and females was equal within the two math anxiety groups and the two experimental testing condition groups. The basic experimental design of this study was a 2 x 2 x 2 factorial design with variables being mathematics anxiety (high, low), threat of evaluation (high, low), and sex (male, female).

Subjects in the high evaluative stress condition received pre-performance instructions emphasizing the importance of performing well and stating that their scores would be compared to other students' scores. Additionally, the subjects were told that their scores would be used to predict performance in college level math courses. The test was administered under strict time limits and subjects were informed that they were expected to complete all of the test items.

Subjects in the low evaluative stress condition were told that their test scores would remain completely anonymous and that test results would be used for normative purposes only. The test was

likewise administered under strict time limits, however the subjects were told that the average college student was very often not able to complete all of the items within the allotted time.

The subjects were then administered the Numerical Ability subtest of the standardized Differential Aptitude Tests. After completion of the DAT mathematics section, subjects were asked to complete the A-state form of the State-Trait Anxiety Inventory (STAI), which served as a self-report measure of situational state anxiety. Subjects were asked on the STAI-A to rate how they felt while taking the DAT. In addition, subjects completed the Cognitive Interference Questionnaire (CIQ; Sarason, 1980), which served as a self-report measure of interfering cognitions that subjects reported experiencing while taking the test. Test Anxiety Scale (TAS) scores were obtained from a battery of entrance tests that all incoming freshmen at DePaul University complete.

RESULTS

Analyses of variance revealed that high math anxious subjects performed significantly poorer on the math performance measure than low math anxious subjects across instruction conditions (F (1/32) = 14.25, $p < .001$). Therefore, there were no significant performance differences between the high evaluative stress and low evaluative stress treatment conditions. Different pre-performance instructions did not differentially affect high and low math anxious subjects' math test performance.

High math anxious subjects also reported significantly higher levels of state anxiety (F (1/32) = 4.25, $p < .05$) and more interfering cognitions during task performance (F (1/32) = 13.85, $p < .001$) than low math anxious subjects across instruction conditions. Additional analyses revealed no significant sex differences for math anxiety or math performance, despite the fact that males reported having taken significantly more math courses than females (F (1/98) = 4.23, $p < .05$).

Pearson product-moment correlations revealed a significant inverse relationship between math anxiety and math test performance as well as a similar relationship between math anxiety and previous number of math courses taken. There was a significant positive relationship between math and test anxiety. However, a t-test comparing the correlation between the MARS and the math performance measure with that of the correlation between the TAS and the math performance measure revealed that the MARS functions as a significantly better predictor than test anxiety scores for performance on a mathematics test (t (32) = -2.10, $p < .05$).

Sex-role identification was not found to relate significantly to math anxiety.

DISCUSSION

The present study corroborates many previous research findings regarding the phenomenon of math anxiety as well as offers new implications with respect to its distintiveness. It is well documented that high levels of math anxiety produce a debilitating effect in math test performance. It also appears consistent that those individuals with less previous experience in mathematics are more prone to experience higher levels of math anxiety. Although females often report having had less exposure to mathematics as compared to males, the distribution of levels of math anxiety appears to be comparable between the sexes. Furthermore, sex-role typing did not emerge in the present study as a significant contributing variable to the prevalence or distribution of math anxiety. This suggests that the current focus on the causes and effects of math anxiety, particularly for women, needs to be reassessed and expanded. The phenomenon of math anxiety has been used as an explanatory variable for lower math performance scores for women as well as their avoidance of math curricula. It may well be that other more salient factors, such as academic advising or peer pressure, account for females' lower rate of enrollment in math courses.

The major hypotheses of the present study concerned the effects of math anxiety on math test performance as a function of different evaluative conditions. Based on the suggestion that the cognitive and emotional components of math anxiety are quite similar to those associated with test anxiety, a typical test anxiety experimental paradigm manipulating evaluative test-taking conditions was used in the present study. The results indicated a significant test performance

decrement for high as compared to low math anxious subjects regardless of pre-performance instructions manipulating the level of situational stress. Neutral, non-evaluative instructions did not facilitate the performance of high math anxious subjects as predicted. Furthermore, high math anxious subjects reported significantly higher levels of state anxiety as well as interfering cognitions across treatment conditions, regardless of the evaluative instruction manipulation. This result is certainly contrary to predictions based on an assumed similarity between math and test anxiety.

These results suggest that math anxiety differs from test anxiety in being less affected by evaluative and/or reassuring instructions. Math anxiety, accompanied by its debilitating behavioral and interfering cognitive effects, appears to be manifested in a more pervasive manner (i.e. in most math situations) and regardless of situational factors manipulating the evaluative dimension of the testing conditions. It thus is suggested that math anxiety may not be as susceptible or amenable as is test anxiety to the situational manipulation of elimination of evaluational stressors. These results demonstrating the pervasiveness of math anxiety lend support to the view that math anxiety is more than test anxiety in that it represents a reaction to mathematical content as well as a reaction to the evaluative form of math tests (Richardson & Woolfolk, 1980; Tobias, 1976). It may well be that the mere act of taking a math test is evaluative enough in its own right to trigger the debilitating effects of math anxiety regardless of any attempts at reassurance or alleviation of situational stress.

The implications for treatment suggested by this pervasive element of math anxiety seem to call for investigating the more fundamental cognitive aspects of math anxiety, such as negative performance expectations and/or perceived self-efficacy. Math anxiety appears to be distinct from test anxiety in its situational pervasiveness as well as in its complexity and content specificity. Math anxious subjects appear to be anxious not only about math test-taking, but also about their skills and ability to deal with the mathematical content and problem-solving involved. For this reason, a multi-faceted treatment program as opposed to a situation-specific anxiety reduction program may well be the preferred mode of intervention for math anxiety.

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